REMARKS

Claims 1-8, 10-14, 16-31, 47 and 48 are pending.

Claims 1 and 11 have been amended to particularly point out and distinctly claim Applicants' invention.

Claim 1 recites an apparatus for determining parallel arc fault energy and means for determining a value of the parallel arc fault energy from the value of voltage at the load and the value of current. See, for example, Figure 7 and the corresponding disclosure.

Claim 11 has been similarly amended.

Claims 2, 4 and 10 have been amended to be consistent with the amendment to Claim 1.

Claims 9 and 15 have been canceled, without prejudice. Applicants expressly reserve the right to file a divisional application including those claims.

Claims 16-31 are allowed.

Claim 5 has been rewritten in independent form to include the limitations of original Claims 1 and 4.

Claim 12 has been rewritten in independent form to include the limitations of original Claim 11.

Claims 47 and 48 have been added. Claim 47 recites that the means for determining a value of voltage at the load includes means for remotely communicating the value of voltage at the load by encoding the value of voltage through a power line carrier signal to the means for determining a value of the parallel arc fault energy. Claim 48 recites that the means for determining a value of voltage at the load includes means for remotely communicating the value of voltage at the load by encoding the value of voltage as a current through a power line carrier current signal to the means for determining a value of the parallel arc fault energy. See, for example, page 15, line 11 through page 16, line 3 of the specification; and Figure 7.

A Fee Sheet and duplicate copy thereof accompany this Amendment

Elections/Restrictions

The Examiner states that "[f]urther remarks provided for claim 10 fail to clearly provide for means for remotely communicating the value of the voltage at the load to the means for determining the value of arc fault energy. Only the claims directed to the elected species will be examined." The Examiner further states that the requirement is proper and is made final. These statements are respectfully traversed.

Claim 10, as amended, recites that the means for determining a value of voltage at the load includes means for remotely communicating the value of voltage at the load to the means for determining a value of the parallel arc fault energy. *See, e.g.,* page 15, line 11 through page 16, line 3 of the specification; and Figure 7. The apparatus 130 includes a detection module 134 and a remote load voltage sensor 136, which measures a value of voltage, V_{LOAD}, at the load 18. The detection module 134 includes the source current sensor 24, which measures a value of the source current 4 flowing in the power circuit 132 to or from the power source 16 (*e.g.*, an AC or DC power source), and a suitable processor, such as microprocessor (μP) 138. The remote load voltage sensor 136 includes a suitable precision switched resistor 140 having a resistance, R_{PRE}, a switch 142, and an electronic switch oscillator 144, which encodes the load voltage as a current 145 through a power line carrier current signal 146. The detection module 134 also includes a demodulator 148, which demodulates the current 145, $I_{DEMODULATED}$, from the power circuit 132, and which, thus, decodes the load voltage, V_{LOAD}, from Equation 8 ($V_{LOAD} = I_{DEMODULATED} \times R_{PRE}$), assuming that the switch 142 has a suitably low impedance.

It is submitted that the elected species of Figure 7 reads on the recited means for remotely communicating the value of voltage at the load to the means for determining the value of parallel arc fault energy.

Applicants' attorney disagrees with the Examiner's statement that the previously provided remarks for Claim 10 fail to "clearly provide" for means for remotely communicating the value of voltage at the load to the means for determining the value of parallel arc fault energy. The exact basis for the Examiner's statement is not understood. The disclosed remote communication means remotely communicates the load voltage by encoding it as a current 145 and by communicating the encoded load voltage through a power line carrier current signal 146. For example, one meaning for "communicate" is to "transmit information … so that it is satisfactorily received or understood". See, for example, http://www.m-w.com/cgi-bin/dictionary?va=communicate. A true and correct copy of this definition is attached hereto as Exhibit A. In this example, the communicated encoded load voltage is satisfactorily received or understood since the disclosed detection module 134 demodulates the current 145 from the power circuit 132 and, thus, decodes the load voltage.

For the above reasons, it is submitted that Claim 10 reads, for example, on the elected species of Figure 7.

In the previous Office Action, the Examiner stated that Claim 10 is withdrawn from further consideration under Rule 142(b) as being drawn to a non-elected species, there

being no allowable generic or linking claim. This statement is traversed. For reasons as are discussed below in connection with the Section 103(a) rejections, Claims 1 and 2 are allowable. These claims are generic to the claimed species of Figure 7.

Furthermore, as was discussed above, Claim 10 reads, for example, on the elected species of Figure 7.

Hence, for the above reasons, it is submitted that Claim 10 should be considered by the Examiner.

Newly added Claims 47 and 48 read on the elected species of Figure 7.

Rejections under 35 U.S.C. § 103(a)

Claims 1-4, 11 and 15 are rejected on the ground of being unpatentable over U.S. Patent No. 5,986,860 (Scott) in view of U.S. Patent No. 6,703,842 (Itimura et al.).

Scott (Figure 2) discloses an apparatus and method for differential current shunt arc detection. "Pilot wires" 35,37 are connected from current transformer sensors 30 and 32 and are directed such that their current flow is to either end of a current summing arc detector 36 which will sum these two currents (which flow in opposite directions such that a "current differential" is detected). In the absence of a shunt arc, such as the arc 34, the currents should be equal such that the net output of the current differential sensor 36 will be zero. This apparatus does not detect a series arc.

Scott (Figure 3) discloses a circuit for a zero-sequence voltage differential method for series arc detection. Scott, col. 6, ll. 22-23. An arc detector 70 comprises comparing means for comparing the two zero-sequence voltages, that is, the respective sums of the voltages on the pilot wires from the load end and source end of the line. Under normal conditions, this zero-sequence voltage arc detector or comparing circuit 70 will produce a difference signal corresponding to any difference between the two zero-sequence voltages at pilot wires 64,66. If there are no series arcing faults in the monitored phase lines, the difference should ideally be zero.

Scott (Figure 13) discloses a circuit 125 for voltage drop series arc detection. This circuit detects the arc voltage itself, symbolized schematically as V_{ARC}. This circuit detects series arcs rather than shunt or parallel arcs. These arcs generate frequency components from DC to the megahertz range and beyond. The arc voltage always opposes the current in the line. The series arc voltage therefore always adds to the line voltage drop such that an unusual increase in voltage drop will indicate an arc in the conductive path. A pilot wire 126 coupled near the load end of the zone feeds one input of an arc detector 128, which may be a voltage detector, for detecting or comparing the voltage on the pilot wire 126

with the voltage at or near the source end of the circuit which is fed to the detector 128 on a line 130. The total voltage drop seen by the detector 128 would then be the line voltage drop due to the nominal line impedance plus the arc voltage. The impedance voltage drop in the line must be subtracted from the total voltage drop at the detector 128 in order to extract the arc voltage.

Scott (Figure 14) shows a circuit 135 for use in a line power loss (arc power) method of arc detection. This method monitors the power loss through a conductor and subtracts out the energy due to resistance. The arc power relates more directly to the potential for equipment damage and other problems, than do other measurements such as arc voltage or arc current alone. The pilot wires or connections 126,130 as in the circuit of Figure 13 supply the line drop voltage to an arc power sensor type of arc detector circuit 132. A current transformer sensor 134 supplies the current in the line from the source end of the line to the arc power sensor 132. Thus, the current times the total voltage drop may be calculated by the arc power sensor 132 to determine the arc power in the presence of an arcing voltage V_{arc} in similar form to the arcing voltage indication as discussed above in connection with Figure 13.

Itimura et al. discloses (col. 6, ll. 1-21) that a short-circuit current flowing in a fault circuit ranges widely. Therefore, short-circuit current in the wide range is detected by a combination of the following three kinds of detecting methods. A first method is applied to a comparatively small current such as a series arc in which a fluctuation pattern peculiar to an arc current is discriminated by extracting a fluctuation pattern of each continuous half wave of an alternating current. In a second method (Itimura et al., col. 6, ll. 10-15), an instantaneous current value is subjected to sampling at regular intervals as to an arc short circuit of a comparatively small current region, and a virtual arc energy is integrated for a constant period to decide whether or not the integrated value exceeds a predetermined threshold value. In a third method, it is decided whether or not the instantaneous value obtained by the sampling exceeds a "constant number of times a predetermined threshold value" when short circuit phenomena in a comparatively large current region is caused or an overload current is generated.

Itimura et al. discloses (col. 12, ll. 61-67) that a generated arc energy Ea of "Ea=∫i. va. dt, t is a time" on an accident point is obtained, wherein i represents the instantaneous value of an accident current and va indicates the instantaneous value of an arc voltage of a generated arc. The "va" can also be regarded as a constant value Va almost

irrespective of a time based on the observation. Therefore, "Ea=Va ∫i. dt" can be obtained by transformation.

Itimura et al. further discloses (col. 13, ll. 1-9) that the arc energy Ea is proportional to a time integration of the instantaneous value of the accident current i. The time integral value of i is approximately represented by an integral value of each sampling value in the case in which the instantaneous value of the accident current is sampled at a proper interval. Although the integral value is not an actual arc energy, it has a value which is almost proportional to a virtual arc energy when an arc voltage is assumed to be constant.

Itimura et al. also discloses (Figure 6, col. 14, l. 65 through col. 16, l. 41) an abnormal current detecting apparatus that employs one of the three kinds of detecting methods. The current of the AC load circuit is detected by current transformer (CT) and is input to two amplifying circuits 12,14 through a load resistor 10 and a filter 11. The amplifying circuits 12,14 have different degrees of amplification and each outputs maximum digital values at 30 A, 300 A respectively when the current is input to low-pass and high-pass current detecting A/Ds of a microcomputer 20. The voltage of the AC load circuit is input to a zero cross comparator 19 through a resistance voltage divider 16, a differential input 17 and a filter 18, and an output repeating 0V and 5V for each zero cross is sent to the voltage detecting input port of the microcomputer 20 respectively. The microcomputer 20 executes a predetermined data processing over the two kinds of current digital vales and a voltage zero cross signal in accordance with a predetermined program including plural algorithms prepared in advance for the three kinds of methods, and outputs immediately an accident detection signal when accident detection is decided, namely discriminate abnormal current.

Claim 1, as amended, recites, *inter alia*, an apparatus for determining parallel arc fault energy in real time for a power circuit between a power source and a load comprising: means for determining a value of voltage at the load; means for determining a value of current flowing in the power circuit to or from the power source; and means for determining a value of the parallel arc fault energy from the value of voltage at the load and the value of current.

The Examiner states that Scott discloses "means for determining a value of voltage at a load [claims 1, 11] (col. 6, lines 64-67)". This statement is traversed as applied to the refined recital of Claim 1, as amended. The Examiner's citation pertains to the arc detector 70 of Figure 3 of Scott. As was discussed above, the arc detector 70 of Figure 3 of Scott (col. 6, ll. 22-23) is a circuit for a zero-sequence voltage differential method for series arc detection. This is completely different than the refined recital of an apparatus for

determining ***parallel*** arc fault energy. Scott (Figure 2) also teaches away from an apparatus for determining parallel arc fault energy comprising means for determining a value of voltage at a load, since the disclosed apparatus and method for shunt or parallel arc detection employs pilot wires 35,37 connected from current transformer sensors 30,32 that are directed such that their current flow is to either end of a current summing arc detector 36 which will sum these two currents.

The Examiner further states that Scott does not disclose any means for determining a value of arc fault energy from a value of voltage at a load and a value of current.

The Examiner also states that Itimura et al. discloses an apparatus and method for arc detection having "means for determining a value of the arc fault energy from the value of voltage and the value of current [claims 1, 11] (col. 4, lines 37-46 and col. 12, lines 65-67)". This statement is traversed as applied to the refined recital of Claim 1.

Actually, the first cited portion of Itimura et al. (col. 4, ll. 40-43) (***emphasis added***) clearly states that "a virtual arc energy is calculated ***by only simple integrating of an absolute value of an instantaneous value of the current*** converted into the digital value in a predetermined restricted period". Hence, this teaches away from the refined recital of a means for determining a value of parallel arc fault energy from a value of ***voltage at a load and*** a value of current.

The second cited portion of Itimura et al. (col. 12, ll. 61-67) discusses an instantaneous value of an arc voltage of a generated arc.

Applicants' specification at page 9, lines 8-10 states that "[t]he downstream load voltage 30, V_{LOAD}, suitably represents the arc voltage of the parallel arc fault 2, with only a relatively small error due to the ohmic drop in that part of the power circuit 14 from the fault 2 to the load 18."

The instantaneous value of an arc voltage of a generated arc of Itimura et al. is, however, different than the recited value of voltage ***at a load***. Furthermore, immediately after the second cited portion, at column 13, lines 1-40 of Itimura et al., it is explained that the arc energy Ea is proportional to a time integration of the instantaneous value of the accident current i. The time integral value of i is approximately represented by an integral value of each sampling value in the case in which the instantaneous value of the accident current is sampled at a proper interval as determined by the detection of voltage zero crossings. Although the integral value is not an actual arc energy, it has a value which is almost proportional to a virtual arc energy when an arc voltage is assumed to be constant.

The alternating current flowing to an AC load circuit is sampled in a predetermined cycle and is converted into a digital value corresponding to an instantaneous current, and an absolute value of the instantaneous value of the current converted into the digital value is integrated within a predetermined restricted section, thereby calculating a virtual arc energy. When the virtual arc energy value thus calculated exceeds a predetermined threshold, it is decided that an abnormal current is generated. Therefore, Itimura et al. expressly teaches away from use of a value of voltage, much less a value of voltage ***at a load***. Hence, at best, Itimura et al. teaches and suggests a means for determining a value of virtual arc fault energy from an integral of a value of current.

Accordingly, Itimura et al. adds nothing to Scott regarding the recited means for determining a value of ***parallel*** arc fault energy from the recited value of voltage ***at a load*** and the recited value of current.

Therefore, for the above reasons, it is submitted that Claim 1 patentably distinguishes over the references.

Claims 2-4 depend directly or indirectly from Claim 1 and patentably distinguish over the references for the same reasons.

Claim 2 is not separately asserted to be patentable except in combination with Claim 1 from which it depends.

Claim 3 is not separately asserted to be patentable except in combination with Claim 2 (and Claim 1) from which it depends.

Furthermore, Claim 4, as amended, recites that the means for determining a value of the parallel arc fault energy includes means for determining a value of parallel arc power from the value of voltage at the load times the value of current, and means for determining the value of the parallel arc fault energy as a function of an integral of the parallel arc power.

The Examiner admits on page 4, paragraph 2 of the present Office Action that Scott does not teach this recital.

For similar reasons as were discussed above in connection with Claim 1, since Itimura et al. adds nothing to Scott regarding a means for determining a value of ***parallel*** arc fault energy from the recited value of voltage ***at a load*** and the recited value of current, it clearly does not teach or suggest any means for determining a value of parallel arc power from a value of voltage at a load times a value of current, and a means for determining such value of such parallel arc fault energy as a function of an integral of such parallel arc power. Again, Itimura et al. teaches away (col. 13, ll. 1-40) from that recital since it expressly

teaches a means for determining a value of virtual arc fault energy from an integral of a value of current.

Claim 11 is an independent claim which, as amended, recites, *inter alia*, a method for determining parallel arc fault energy in real time for a power circuit between a power source and a load comprising: determining a value of voltage at the load; determining a value of current flowing in the power circuit to or from the power source; and determining a value of the parallel arc fault energy from the value of voltage at the load and the value of current.

The Examiner states that Scott discloses "determining a value of voltage at a load [claims 1, 11] (col. 6, lines 64-67)". This statement is traversed as applied to the refined recital of Claim 11, as amended. The Examiner's citation pertains to the arc detector 70 of Figure 3 of Scott. As was discussed above, the arc detector 70 of Figure 3 of Scott (col. 6, ll. 22-23) is a circuit for a zero-sequence voltage differential method for series arc detection. This is completely different than the refined recital of determining ***parallel*** arc fault energy. Scott (Figure 2) also teaches away from determining parallel arc fault energy and determining a value of voltage at a load, since the disclosed apparatus and method for shunt or parallel arc detection employs pilot wires 35,37 connected from current transformer sensors 30,32 that are directed such that their current flow is to either end of a current summing arc detector 36 which will sum these two currents.

The Examiner further states that Scott does not disclose any determining a value of arc fault energy from a value of voltage at a load and a value of current.

The Examiner also states that Itimura et al. discloses an apparatus and method for arc detection "determining a value of the arc fault energy from the value of voltage and the value of current [claims 1, 11] (col. 4, lines 37-46 and col. 12, lines 65-67)". This statement is traversed as applied to the refined recital of Claim 11.

Actually, the first cited portion of Itimura et al. (col. 4, ll. 40-43) (***emphasis added***) clearly states that "a virtual arc energy is calculated ***by only simple integrating of an absolute value of an instantaneous value of the current*** converted into the digital value in a predetermined restricted period". Hence, this teaches away from the refined recital of determining a value of parallel arc fault energy from a value of ***voltage at a load and*** a value of current.

The second cited portion of Itimura et al. (col. 12, ll. 61-67) discusses an instantaneous value of an arc voltage of a generated arc.

Applicants' specification at page 9, lines 8-10 states that "[t]he downstream load voltage 30, V_{LOAD}, suitably represents the arc voltage of the parallel arc fault 2, with only a relatively small error due to the ohmic drop in that part of the power circuit 14 from the fault 2 to the load 18."

The instantaneous value of an arc voltage of a generated arc of Itimura et al. is, however, different than the recited value of voltage ***at a load***. Furthermore, immediately after the second cited portion, at column 13, lines 1-40 of Itimura et al., it is explained that the arc energy Ea is proportional to a time integration of the instantaneous value of the accident current i. The time integral value of i is approximately represented by an integral value of each sampling value in the case in which the instantaneous value of the accident current is sampled at a proper interval as determined by the detection of voltage zero crossings. Although the integral value is not an actual arc energy, it has a value which is almost proportional to a virtual arc energy when an arc voltage is assumed to be constant. The alternating current flowing to an AC load circuit is sampled in a predetermined cycle and is converted into a digital value corresponding to an instantaneous current, and an absolute value of the instantaneous value of the current converted into the digital value is integrated within a predetermined restricted section, thereby calculating a virtual arc energy. When the virtual arc energy value thus calculated exceeds a predetermined threshold, it is decided that an abnormal current is generated. Therefore, Itimura et al. expressly teaches away from use of a value of voltage, much less a value of voltage ***at a load***. Hence, at best, Itimura et al. teaches and suggests determining a value of virtual arc fault energy from an integral of a value of current.

Accordingly, Itimura et al. adds nothing to Scott regarding the recited determining a value of ***parallel*** arc fault energy from the recited value of voltage ***at a load*** and the recited value of current.

Therefore, for the above reasons, it is submitted that Claim 11 patentably distinguishes over the references.

Newly added Claims 47 and 48 depend from Claim 1 and patentably distinguish over the references for the same reasons. Furthermore, Claim 47 recites that the means for determining a value of voltage at the load includes means for remotely communicating the value of voltage at the load by encoding the value of voltage through a power line carrier signal to the means for determining a value of the parallel arc fault energy.

Scott, which discloses an arc detector 70 and comparing means for comparing two zero-sequence voltages, that is, the respective sums of the voltages on the pilot wires

from the load end and source end of the line, and which discloses pilot wires 35,37 connected from current transformer sensors 30,32 that are directed such that their current flow is to either end of a current summing arc detector 36 which will sum these two currents, does not teach or suggest any means for remotely communicating a value of voltage at a load by encoding such value of voltage through a power line carrier signal. Itimura et al., which determines a value of virtual arc fault energy from an integral of a value of current, and which employs a voltage zero cross signal to sample absolute values of an instantaneous value of current for integration of only that current, adds nothing to Scott in that regard. Hence, it is submitted that Claim 47 further patentably distinguishes over the references.

Furthermore, Claim 48 recites that the means for determining a value of voltage at the load includes means for remotely communicating the value of voltage at the load by encoding the value of voltage as a current through a power line carrier current signal to the means for determining a value of the parallel arc fault energy. Claim 48 further patentably distinguishes over the references for similar reasons as were discussed above in connection with Claim 47.

Objections to the Claims

The Examiner states that Claims 5-8 and 12-14 are objected to as depending from a rejected based claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claim.

Claim 5 has been rewritten in independent form including the limitations of Claims 1 and 4. Claims 6-8 depend from Claim 5. Accordingly, it is submitted that Claims 5-8 are in proper form for allowance.

Claim 12 has been rewritten in independent form including the limitations of Claim 11. Claims 13 and 14 depend from Claim 12. Therefore, it is submitted that Claims 12-14 are in proper form for allowance.

Allowable Subject Matter

It is noted with appreciation that the Examiner states that Claims 16-31 are allowed.

Summary and Conclusion

The prior art made of record and not relied upon but considered pertinent to Applicants' disclosure has been reviewed. In summary, it is submitted that Claims 1-8, 10-14, 16-31, 47 and 48 are patentable over the references of record.

Reconsideration and early allowance are requested.

Respectfully submitted,

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